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Livestock Grazing and Wildlife Conservation in the Indian Trans-Himalaya
— A Preliminary Survey

A Report Submitted to

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By

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An Overview

This report synthesizes the results of the first phase of a long-term study that addresses a serious conservation issue in the Indian trans-Himalaya - livestock grazing within protected areas established for wildlife conservation. Field-work for this survey was conducted between May and August, 1996, in Kibber Wildlife Sanctuary in Spiti region of the north Indian state of Himachal Pradesh. The report is organized in three parts. In Chapter 1, I analyze the socio-economic changes in the study area during the last 25 yr, and the impact of these changes on wildlife conservation. Chapter 2 addresses an acute human-wildlife conflict in the area - depredation of livestock by snow leopard *Uncia uncia* and Tibetan wolf *Canis lupus chanku*, and the retaliatory persecution of these carnivores by the local human community. Appendix 1 presents the results of an avifaunal survey of two ecologically important wetlands in the adjoining region of Ladakh.

During the course of four months in field, I also studied livestock diet, plant species-abundance and phenology in the pastures, and gathered information on bharal *Pseudois nayaur* habitat use and collected their faecal samples for later analysis. Owing to the short duration of the study and therefore the limited sample sizes, this data is not presented here. The information will be used at a later stage after I spend more time in the field, and will be incorporated in future reports. I shall submit a copy of this report to the Forest Department, Himachal Pradesh.

Chapter One

Social Transformation and Wildlife Conservation in a Trans-Himalayan Wildlife Reserve

Abstract: The agro-pastoralist Buddhist community in Spiti region of the Indian trans-Himalaya has undergone radical socio-economic transformation in the last decade. During this period, Spiti has also seen the creation of two wildlife reserves covering 17 % of its area. With 36 % of Spiti's human population residing within or in the vicinity of the reserves, there is substantial dependence on the reserve area for grazing and fuelwood. I analyzed the social transformation of 3 villages (80 households) around Kibber Wildlife Sanctuary during the last 25 years, and its impact on wildlife conservation. While the human population has remained constant during this period, overall literacy rate has doubled from 21.8 % in 1971 to 48.1 % in 1996. Changes in agriculture and animal husbandry practices in the last decade have resulted in a transformation from subsistence to market economy. There has been a 37.7 % increase in livestock holding during this period. As a consequence, human-wildlife conflict in terms of livestock depredation by snow leopard *Uncia uncia* and Tibetan wolf *Canis lupus chanku*, and the persecution of the wolf by the villagers, has intensified. A sudden unplanned development of a tourism industry in the last three years has resulted in pollution and natural resource exploitation. Properly designed conservation initiatives and an ecologically sensitive tourism plan need to be undertaken. With the likely breakdown of social population regulation mechanisms in the near future, the need for family planning education is apparent. Almost total literacy in the coming generation provides an opportunity to control the human population before it enters a phase of rapid growth.

INTRODUCTION

The industrial revolution, population explosion, and the development of a global exchange economy are predominant factors that have influenced land use changes and associated biodiversity loss (Machlis 1992; Tisdell 1994). Although specific human activities that degrade natural resources and natural populations vary depending upon the area or species examined (Sala 1992; Kerr and Currie 1995), socio-economic systems almost invariably influence the pattern of natural resource use and degradation (Sala 1992). The ultimate causes of human induced extinctions of natural populations are presumably socio-economic in origin (Myers 1988; Gullison & Losos 1993; Kerr & Currie 1995).

Human communities interspersed in the once remote wilderness areas of India are undergoing socio-economic change in the face of modernization (Goldstein 1981; Fox *et al.* 1994). Given the fact that more than 80 % of the wildlife reserves in India have human presence and some level of natural resource use (Kothari *et al.* 1989), it becomes imperative that the socio-economic transformation of such communities, and its impact on wildlife resources, be closely monitored.

The trans-Himalaya spans over 2.6 million km^2 of the high altitude plateau of Tibet. The *c.*186,000 km^2 within India forms one of the least represented biogeographic zones in the Indian protected area network (Rodgers and Panwar 1988). This is despite the conservation significance of this zone, evident from the fact that it harbours 12 species of mammals and birds listed in Schedule I of the Indian Wildlife (Protection) Act, 1972 (Anon. 1992), at least four of them globally threatened (IUCN 1990). The high potential instability and vulnerability inherent of mountain ecosystems (Skeldon 1985; Hurni *et al.* 1987) renders the trans-Himalaya one of the most ecologically fragile biogeographic zones in India (Rodgers & Panwar 1988). Demographic, economic, and social changes, therefore, have important consequences on conservation of trans-Himalayan wildlife (Fox *et al.* 1994). In this paper, I examine the social transformation of an agro-pastoral Buddhist community during the last 25 years, and its impact on wildlife conservation in Kibber Wildlife Sanctuary in Spiti region of the Indian trans-Himalaya.

STUDY AREA

Kibber wildlife sanctuary (32° 5' to 32° 30' N and 78° 1' to 78° 32' E) is situated in the trans-Himalayan district of Lahaul & Spiti in the state of Himachal Pradesh. The sanctuary occupies an area of 1,400 km^2 in the catchment of the river Spiti. Bordered by Ladakh on the north and Tibet on the east, it is a cold desert area ranging in altitude from about 3,600 m to almost 6,700 m above mean sea level. Winter temperature ranges from -30°C to 3°C. In summer, it ranges from 1° C to 28° C (Rana 1994). Vegetation in the area has been broadly classified as dry alpine steppe (Champion & Seth, 1968).

Spiti region (31° 42' to 32° 58' N and 77° 21' to 78° 35'E) spans over an area of 12210 km^2. The human population of 9591 (in 1991; Directorate of Economics and Statistics 1994) is largely Buddhist (Kaushik 1993). Kibber Wildlife Sanctuary is flanked by 13 villages along its southern boundary inhabited by this agro-pastoral community.

The main occupations of the inhabitants are agriculture and livestock rearing. Most activities related to agriculture are restricted to the short growing season from May to September. Barley *Hordeum vulgare* and green peas *Pisum sativum* are the main crops cultivated. Livestock includes goat and sheep, cattle, '*dzomo*' (female hybrid of cattle and yak), and yaks. Goat, cattle and dzomo are used for both milk and meat. In addition to meat, sheep are used for wool, and yaks for ploughing. Donkeys are the beasts of burden, while horses, apart from being used for religious ceremonies, are mainly raised for trade.

Large mammalian fauna of the area includes the bharal *Pseudois nayaur*, relatively few ibex *Capra ibex*, and their predators - the snow leopard *Uncia uncia* and the Tibetan wolf *Canis lupus chanku*. Other fauna includes the red fox *Vulpes vulpes*, pale weasel *Mustela altaica*, stone marten *Martes foina*, and the Himalayan mouse hare *Ochotona* sp.

METHODS

Secondary data on human population and literacy rate in the past, livestock population, and developmental changes in the region over the last 25 years were collected from Government office records. Of the 13 villages surrounding Kibber wildlife sanctuary, three villages, which together accounted for 19% of the population, were selected as samples for the study. This included Kibber, the largest in the area (316 inhabitants), and two small nearby villages, Gete (36) and Tashigang (24). At least one member from each household in the three villages was interviewed to obtain information regarding present human population and literacy rates, livestock population, land holding, past and present agricultural practices.

Crop yield per unit area was obtained for different crops by interviewing two experienced farmers, and the lower limit of the reported range was used for calculating annual production for each crop. Casual observations on tourism and its impact were made during the course of four months (May to August, 1996) of field-work.

RESULTS

Human population and literacy rate

Human population in the 13 villages bordering the sanctuary increased at an annual growth rate of 0.09 % between 1971 and 1991 (1,985 in 1991; data for 1996 were not available), representing a 1.8 % increase in 20 years. Between 1971 and 1996, the three study villages underwent a 6.5 % increase in human population (from 353 to 376) at an average annual growth rate of 0.25 %. Children < 18 years comprise 49.2 % of the present population.

Overall literacy rate in the three study villages has increased from 21.8 % to 48.1 % in the last 25 years. Presently, 30.7 % of the adult males (n = 91), and 26.0 % of the adult females (n = 100) are literate. Among children of school-going age (*c.* 5 to 18 years), there is 96.9 % literacy (n = 127).

Development

Among some indicators of development, the number of medical facility centres and post offices in the study villages has remained constant in the last 25 years (Table 1). However, this period has seen an increase in the number of schools and the electrification of all three villages. Two of the three villages, Gete and Tashigang, which earlier had no roads, have been connected by motorable roads.

Table 1. Patterns in some indicators of development in the 3 study villages adjoining Kibber wildlife sanctuary, Indian trans-Himalaya

	1971	1987
Number of medical facility centres	1	1
Number of post offices	1	1
Number of schools	1	4
Irrigated land (ha)	83.39	90.64
People per ha irrigated land	4.2	4.1
Number of villages with electricity supply	0	3
Number of villages connected by motorable road	1	3

Agriculture

The area under irrigated crop fields increased marginally in the last 25 years, though the number of people per unit irrigated land has remained the same (Table 1). The average land holding per household presently is 1.13 ha. Prior to 1986, agriculture was for subsistence. The main crops were barley *Hordeum vulgare* and a local variety of pea *Pisum* sp. cultivated on two-thirds and one-third of the land holding respectively. Since 1986, however, one-third of the land holding is cultivated with green peas *P. sativum*, one-third with barley, and the remaining is partly planted with local pea and partly left fallow. The entire harvest of green pea, which has largely replaced barley, is sold as a cash crop. The estimated annual production per household of green peas is 2587 kg, which translates into a *per capita* profit (corrected for transport costs) of US$ 210 per year (1994-95 conversion rate of 1 US$ = 31.4 Indian Rupees; World Bank 1996). The estimated production of barley per household per year is 1294 kg.

With this change in cropping pattern from barley to green peas, an age-old barter trade with a semi-nomadic pastoral community, *Changpa* of Ladakh, is on the verge of permanent breakdown. *Changpa* herders have been coming into Kibber region for at least a few centuries (Kapadia 1996) from Ladakh. They come in summer with their stock (> 1000 goat and sheep) after the opening of the 5600 m Parang La (pass).

Barley, that earlier was in surplus, was bartered with the *Changpa* mainly in exchange for wool and salt. With one-third of the land now set aside for green peas, barley is no longer in surplus to barter. Casual interviews of several people in the study villages, and one *Changpa* group, indicated that this barter trade will completely break down within the next five years.

Livestock holding

Livestock data for Kibber village for the year 1971 were not available. Gete and Tashigang together showed a 52.2 % increase in livestock holding between 1971 and 1987 (Table 2). This translates to an annual growth rate of 2.6 %. Including Kibber, there has been a 37.7 % increase after 1987, indicating a 3.5 % annual increase in livestock holding (Table 3).

Table 2. Increase in livestock numbers in two of the sampled villages (Gete and Tashigang) between 1971 and 1987

	1971	1987	Percent increase
Yak	9	14	
Cattle / Dzomo	13	32	
Horse	6	11	
Donkey	11	17	
Sheep / Goat	76	101	
TOTAL	**115**	**175**	**52.2**

In terms of herd composition, Gete and Tashigang show an increase in all livestock species between 1971 and 1987, though maximum increase was accounted for by goat/sheep (Table 2). After 1987, however, the population of cow/*dzomo* in the sampled villages declined marginally, while the yak numbers increased more than three-fold (Table 3). Goat/sheep still account for maximum increase in livestock holding (57.4 %).

Tourism

Lying close to the politically sensitive Sino-Indian border, Spiti remained a restricted area until three years ago. Thus, since 1993, there has been a sudden growth in tourism. Kibber, one of the study villages, had three functional hotels and one more under construction when this study was conducted, as opposed to none before 1993. These hotels, catering to both Indian and foreign tourists, are run by local villagers. The tourist inflow is restricted to between June and September. Between June and August 1996, one of the hotel owners reported a net profit of *c.* US$ 637. Demand for local guides and donkeys by trekking tourists also causes a substantial inflow of money. This however, could not be quantified.

Table 3. Increase in livestock numbers in the three sampled villages between 1987 and 1996

	1987	**1996**	**Percent increase**
Yak	42	139	231
Cattle / Dzomo	145	126	-13.1
Horse	45	75	66.7
Donkey	110	125	13.6
Sheep / Goat	423	589	39.2
TOTAL	**765**	**1054**	**37.8**

Wildlife conservation

There were no wildlife reserves in Spiti until the last decade. The formation of the 675 km^2 Pin Valley National Park (31°44' to 32°11' N and 77°45' to 78°06' E) in 1987, and Kibber wildlife Sanctuary in 1992, has resulted in 17 % coverage of Spiti's area as wildlife reserve. Pin Valley has a human population of 1500 inside and around the national park area. In Kibber, all villages are along the boundary of the sanctuary. The boundaries, however, are only administrative. Inhabitants in both the areas, who together constitute 36 % of Spiti's human population, use the reserve areas for livestock grazing, and fuel and fodder collection.

In the last 5 years, increased livestock depredation by snow leopard and Tibetan wolf has intensified the human-wildlife conflict in the area. The depredation attributed by the villagers to these wild carnivores amounts to 1.6 livestock heads per household annually, which in economic terms, translates to a loss per household equivalent to half of the annual per capita income (see Chapter 2). To reduce the depredation, villagers have been killing the wolf. However, so far active killing of snow leopard has not started (see Chapter 2).

Kibber Wildlife Sanctuary, like some other regions of Spiti, has deposits of nautiloid, balamanite, and ammonite fossils. Locals reported that fossils were being removed from the area before Spiti was opened to tourists. However, this was confined to geologists and amateur collectors. Tourism after 1993 has created a market for fossils which is causing a rapid depletion of the fossil reserve of Kibber sanctuary and elsewhere in Spiti. The magnitude of this trade could not be quantified. Depending upon the size and quality, locals are able to sell each fossil for amounts ranging from US$ 3 to US$ 15, which the tourists seem to be able to easily afford.

With increased tourism, the age-old *c.* 125 km trade route between Kibber and Ladakh has become popular as a trekking route. This route is getting polluted due to discarded garbage (including non-degradable metal cans and polythene), especially around the approximately 15 camping sites (Kaushik 1994; see Appendix 1).

Not related directly to the changing land use but still an important threat to wildlife conservation in the sanctuary is the poaching of bharal by army personnel. Local information yielded that bharal are poached during the annual training camps for villagers conducted by the army. At least three bharal were reported to be poached near Kibber village during the course of this work, though this could not be verified.

DISCUSSION

In developing countries, most habitat change and biodiversity loss is the result of socio-economic change in growing rural populations (Machlis 1992). The Indian population, 74 % of which is rural, has grown at an annual rate of 2.17 % in the last two decades (Repetto 1994). The increase in rural population around Kibber Wildlife Sanctuary during this period, however, has been negligible. This could largely be attributed to an intact primogeniture social system in Spiti, where the eldest son in the family inherits all the property, while the younger brothers become celibate monks (Mamgain 1975; Punjab Government 1994).

Faced with modernization, other trans-Himalayan Buddhist communities are known to be undergoing rapid population growth following a breakdown of social population regulation mechanisms (Goldstein 1981). In the face of current socio-economic transformation, this is likely to happen in Spiti. The need for family planning education, especially among the villages adjoining the wildlife reserves, is obvious. The almost total literacy in the coming generation provides an opportunity for controlling the population before it enters a phase of rapid growth.

The change in cropping pattern in the study area in the last decade has hastily transformed the subsistence economy into a market economy. The estimated *per capita* return from green pea harvest is almost as high as the average annual *per capita* income for Himachal Pradesh in general (US$ 248, 1994-95; World Bank 1996). This recently developed aptitude for a market economy is now changing livestock rearing into a commercial practice. This is reflected in the three-fold increase of yaks in the last decade. Yaks raised in the villages around Kibber Wildlife Sanctuary are now being sold in other areas of Spiti (Chhewang D. Zangpo, Spiti *pers. comm.*).

The escalated depredation of livestock by wild carnivores in the last five years seems to be related to the increasing livestock holding. Livestock outnumber bharal, an important prey of the snow leopard, by an order of magnitude in the study area (see Chapter 2). With the trend towards commercialization, along with an augmented ability to purchase artificial feed (needed to supplement livestock diet during winter months), livestock holdings are likely to enlarge in future. This will intensify the human-wildlife conflict even more. Although only the wolf, because of the relative ease in locating its dens, has been persecuted until now, elimination of the snow leopard is likely to be resorted to in the near future (see Chapter 2). In addition, high stocking rates may degrade the pastures and their affect their wildlife populations. Concern over reducing wild prey due to increased numbers of livestock in snow leopard habitat has been expressed elsewhere (Braden 1988).

Uncontrolled tourism in wildlife reserves usually results in conservation problems (Budowski 1976; deGroot 1983; Kenchington 1989). There is a need for a culturally and ecologically well planned tourism plan for Spiti (Kaushik 1993, 1994). The potential threat due to tourism-caused pollution in the wildlife areas makes it especially important that the forest department develop and implement such a plan in Kibber Wildlife Sanctuary. At present, the sanctuary lacks even a record of the number of tourists visiting the area.

Increasing livestock holding and pollution due to unplanned tourism are immediate threats to wildlife conservation in the study area. These problems need to be addressed with urgency, along with a strong enforcement to prevent depletion of the sanctuary's fossil reserve, the persecution of wild carnivores, and the poaching of bharal.

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Chapter Two

Livestock Depredation by Large Carnivores in the Indian Trans-Himalaya — Conflict Perceptions and Conservation Prospects

Abstract: Livestock depredation by snow leopard *Uncia uncia* and Tibetan wolf *Canis lupus chanku* has resulted in a human-wildlife conflict that hinders the conservation of these globally threatened carnivores throughout their range. I analyzed the alleged economic loss due to livestock depredation by these animals, and the retaliatory responses of an agro-pastoral community around Kibber Wildlife Sanctuary in the Indian trans-Himalaya. The three villages studied (80 households) attributed a total of 189 livestock deaths (18 % of the livestock holding) over a period of 18 months to wild predators. This translates into a loss per household of half the average annual *per capita* income. Locals have been killing the wolf, though active elimination of the snow leopard has so far not occurred. Financial compensation offered by the Government is not adequate. A self-financed compensation scheme, and modification of existing livestock pens are suggested as area-specific short-term measures to reduce the conflict. The need to address the problem of increasing livestock holding in the long run is emphasized.

INTRODUCTION

The intimate interspersion of people in wilderness areas often results in conflicts between humans and wildlife (Rodgers, 1989). Most wildlife protected areas in India support various forms of land use such as agriculture, livestock grazing, and collection of minor forest produce. Livestock grazing is especially widespread, and livestock holdings form an important component of the local pastoral and agricultural economy. Kothari *et al.*(1989) report livestock grazing in as many as 73 % of the wildlife sanctuaries and 39 % national parks in India (of the 101 and 14 surveyed protected areas respectively), with livestock densities up to 1500 per km^2. Not surprisingly, livestock outnumber wild ungulates within many protected areas, often by orders of magnitude. Such a disproportionate presence of wild and domestic ungulates results in killing of livestock by wild predators, and thereby a conflict of interests between local communities and wildlife managers.

Human-wildlife conflicts are acute when the species involved is highly imperiled while its presence in an area poses a serious threat to human welfare (Saberwal *et al.* 1994). Such is the conflict between wild carnivores and pastoralists in the trans-Himalaya, one of the most fragile, and yet the least represented of all the biogeographic zones in the Indian protected area network (Rodgers & Panwar 1988). This biogeographic zone harbours 12 mammal and bird species listed as endangered in Schedule I of the Indian Wildlife (Protection) Act, 1972 (Anon. 1992). Among these, the snow leopard *Uncia uncia* is globally threatened, and is categorised as endangered (in danger of extinction) by the IUCN (1990). The Tibetan wolf *Canis lupus chanku*, represents another globally threatened species, categorised as vulnerable (IUCN 1990). Both these species are in conflict with humans in most parts of their range, specifically due to the damage they cause to livestock (Schaller 1977; Fox *et al.* 1988; Mallon 1988; Oli *et al* 1994; Novell & Jackson 1996).

This paper examines the conflict between these wild predators and agro-pastoralists around Kibber Wildlife Sanctuary, an area of acute conflict in Spiti region of the north Indian state of Himachal Pradesh. The paper first establishes the economic loss to local communities due to the perceived wild carnivore predation on livestock, and then qualitatively describes the retaliatory persecution of the carnivores. Area-specific extenuatory measures to reduce the conflict are discussed, and the need for their urgent implementation emphasized.

STUDY AREA

Kibber Wildlife Sanctuary (32°5' to 32°30' N and 78°1' to 78°32' E) is situated in the Spiti region of the trans-Himalayan district of Lahaul & Spiti in Himachal Pradesh. The sanctuary occupies an area of 1400 km^2 in the catchment of the river Spiti. Bordered by Ladakh on the north and Tibet on the east, it is a mountainous cold desert where altitudes range between ca. 3600 m and 6700 m above mean sea level. In winter, temperatures range between -30°C to 3°C, and between 1°C to 28°C in summer (Rana 1994). The vegetation of this area has been broadly classified as dry alpine steppe (Champion & Seth, 1968).

Large mammalian fauna of the area includes bharal *Pseudois nayaur*, relatively few ibex *Capra ibex*, and their predators - the snow leopard and the Tibetan wolf. Other fauna includes the red fox *Vulpes vulpes*, pale weasel *Mustela altaica*, stone marten *Martes foina*, and the Himalayan mouse hare *Ochotona* sp. During the course of this study, 45 species of birds were identified including several species typical of this alpine habitat such as chukar *Alectoris chukar* and Tibetan snowcock *Tetraogallus tibetanus* (see Appendix II).

Thirteen villages are located along the boundary of the sanctuary supporting a total human population of 1985 (according to the 1991 census). The main occupations of the inhabitants are agriculture and livestock rearing. Most agriculture-related activities are restricted to the short growing season from May to September. The main crops cultivated are barley *Hordeum vulgare* and green peas *Pisum sativum*. Livestock includes goat and sheep, cattle, '*dzomo*' (cattle-yak hybrid), and yaks. Donkeys are the beasts of burden, while horses, apart from being used for religious ceremonies, are mainly raised for trade. All these animals graze in the sanctuary area.

METHODS

Secondary data from the 1991 census of the human population for all the 13 villages bordering the sanctuary was collected from Government records. Of these, three villages, viz. Kibber, the largest in the area, and two small nearby villages called Gete and Tashigang were selected as samples for the study. These accounted for 19 % of the total human population of the 13 villages.

At least one member from each household in the three villages was interviewed. They were asked whether they had lost any livestock in the previous one and a half years (January, 1995, to July, 1996) to wild predators. They were also asked if they had applied for and received financial compensation from the local wildlife department. The species, age, and sex of livestock reportedly killed by wild predators was recorded. Information was also collected on the present livestock holding. To estimate the average market value of different classes of livestock species by age and sex, I interviewed butchers, horse traders, and other people frequently involved in buying and selling livestock. This value refers to the average amount of money required to buy an animal of a particular species. Financial compensation rates were obtained from the forest department of the Government.

The focus of this particular study was the perceived livestock loss to the wild predators, and therefore the cases of mistaken but unintentional attribution of livestock deaths to wild predators were included. Precautions were taken, however, against intentional exaggeration by cross-checking the information provided by the respondents, although this was not done systematically. The survey was conducted after I had spent about 3 months in the area, during which time the villagers had realized that I had no direct control over policy making or implementation of any wildlife management programme (including financial compensation).

RESULTS

The 80 households of the three study villages - Kibber, Gete, and Tashigang- owned 1,054 heads of livestock in August 1996 when this survey was conducted (Table 1). Most of the households owned goat/ sheep (95 %) and at least a cow or *dzomo* (89 %). Fewer had donkeys (79 %) and yaks (65 %), while only 55 % of the households owned horses. A total of 189 livestock deaths (18 % of the livestock holding) over a period of 1.5 yr preceding the survey was attributed by the villagers to wild predators. This amounted to 1.6 livestock heads/ household/ year and an annual loss of 12 % of the livestock holding.

Table 1. Livestock population, alleged kills by wild predators, and the percent economic loss in three surveyed villages adjoining Kibber wildlife sanctuary, Indian trans-Himalaya.

	YAK	HORSE	COW / *DZOMO*	DONKEY	GOAT / SHEEP
LIVESTOCK POPULATION	139	75	126	125	589
ALLEGED KILLS	31	26	0	18	114
% KILLS / % ABUNDANCE	1.24	1.94	0	0.79	1.07
% ECONOMIC LOSS	15.4	37.4	0	5.1	42.1

The market values of livestock by age and sex are summarized in Tables 2 and 3. Using these figures, the alleged economic loss due to wild predators amounted to US$ 15,418, which translated into US$ 128/ household/ year (1994-95 conversion rate of 1 US$ = 31.4 Indian Rupees; World Bank,1996).

Of the 131 reported cases in 1995, villagers had applied for monetary compensation in 54 cases and received compensation for 28 cases (amounting to US$ 307). Considering an average perceived annual loss of US$ 10,279, the compensation for 1995 amounted to 3 % of the perceived annual loss. It must be noted here that 'perceived loss' also includes those deaths for which the villagers may not have been certain about the cause.

Table 2. Market value (US $) of goat and sheep by age and sex around Kibber wildlife sanctuary, Indian trans-Himalaya (1994-95 conversion rate of 1 US$ = 31.4 Indian Rupees; World Bank 1996)

	GOAT		**SHEEP**	
	Male	Female	Male	Female
4 months	8.0	6.4	15.9	12.7
6 months	15.9	12.7	31.8	25.4
12 months	31.8	25.4	57.3	44.6
18 months	51.0	31.8	63.7	60.5
> 24 months	63.5	57.3	63.5	60.5

Table 3. Market value (US $) of different livestock species by age and sex around Kibber wildlife Sanctuary, Indian trans-Himalaya (1994-95 conversion rate of 1 US$ = 31.4 Indian Rupees; World Bank 1996)

	YAK	**HORSE**		***DZOMO***	**CATTLE**		**DONKEY**	
		Male	Female		Male	Female	Male	Female
6 months	31.8	0.0	0.0	0.0	0.0	0.0	9.6	4.8
1 year	63.6	127.4	95.5	41.4	15.9	31.8	9.6	4.8
2 years	95.5	254.8	159.2	82.8	57.3	63.7	25.5	8.0
3 years	127.4	382.2	302.5	95.5	63.7	79.6	44.6	25.5
4 years	175.2	477.7	350.3	127.4	63.7	95.5	63.7	25.5
5 years	207.0	573.2	382.2	127.4	63.7	95.5	63.7	25.5
6 years	222.9	573.2*	382.2**	127.4	63.7	95.5	63.7	25.5
> 7 years	238.9	--	--	127.4	63.7	95.5	63.7	25.5

* male horses usually sold off by this age
** the price of female horses starts declining with age • 6 years

Perceived kills of goat/ sheep and horses accounted for 42.1 % and 37.4 % of the economic loss respectively. In terms of the proportion of livestock heads, yaks (16.4 %) followed goat/sheep (60.3 %) (Table 1). Among all livestock species, only horses were reported to be killed significantly more in proportion to their relative abundance ($\square^{2}$=37.32, df= 4, p $\square$ 0.01). Except cow and *dzomo* which were not preyed on, all the remaining species were lost in proportion to their relative abundance (Table 1).

Retaliation by the villagers

Spiti in general and the villages around Kibber wildlife sanctuary in particular have been areas of high conflict between agro-pastoralists and wild predators. Despite being Buddhists, locals have been killing the wolf. They locate wolf dens and capture the pups. The pups are then paraded live around the neighbouring villages where people reward the captors with money. The litter is then destroyed, often using dynamite. According to locals, wolf litters were destroyed around Kibber village almost every year in the 1980s. Wolf has reportedly not littered in this part of the sanctuary for the last 4-5 years and has rarely been sighted. Almost all the livestock kills reported in this paper were attributed to the snow leopard.

Livestock depredation by the wolf was reported from other parts of the sanctuary during the study period. Authentic local information revealed that a wolf litter was destroyed this year (1996) near Hikkim, one of the 13 villages bordering the sanctuary. Locals also brought a live litter of 4 pups captured near a distant Spiti village called Losar to the forest department.

I could establish only one case where an adult snow leopard was killed after it was accidentally trapped inside a pen in Kibber village 4-5 years ago. But for this incident, they are persecuted no more than by occasionally driving them off their livestock kills.

DISCUSSION

The conflict

Conflicts between humans and wildlife in India are escalating due to increasing human population, loss of natural habitats, and in some regions, increasing wildlife populations as a result of successful conservation programs (Rodgers 1989; Sukumar 1989; Saberwal et al. 1994; Williams & Johnsingh 1996). In Kibber wildlife sanctuary, though the killing of livestock by wild carnivores is not a recent phenomenon, it has especially increased in the last 5 years according to locals and forest department officials. This period coincides with the declaration of the area as a wildlife sanctuary in 1992. However, the escalated conflict has little to do with increased protection to wild carnivores. This is evident from the continued destruction of wolf litters in the area. Human population in the study villages has also remained almost the same, with a negligible increase of 1.8 % in the last 25 years (see Chapter 1). The increased conflict seems to be related to a 37.7 % increase in livestock population between 1987 and 1996, which has accompanied a change from subsistence to commercial agriculture and animal husbandry in the last decade (see Chapter 1). Shifts in carnivore diets in response to changes in relative abundance of prey species have been documented (Kitchner 1991; Chellam 1993; Khan *et al.* 1996). Livestock, due to their reduced escape abilities compared to wild herbivores, become especially vulnerable to predation (Nowell and Jackson 1996).

Actual rates of predation on livestock in Kibber are not available. This is not easy to establish, since the losses attributed to wild predators are usually exaggerated, either deliberately, or due to inability in ascertaining the cause of death (Wagner 1988; Hoogesteijn *et al.* 1993; Mizutani 1993; Oli *et al.* 1994). High predation levels on livestock by snow leopard and wolf have been reported from other parts of their range (Schaller 1977; Fox *et al.* 1988; Mallon 1988; Oli *et al.* 1994; Nowell & Jackson 1996). Likewise, in Kibber too, livestock seem to constitute important prey for the snow leopard. Although I do not have robust estimates of wild ungulate abundance, I counted about 60 bharal, an important prey of the snow leopard (Fox 1989; Jackson 1991; Chundawat 1994), within the ecological unit (ca. 20-30 km^2) that encompasses the pastures of the three study villages. Field surveys indicated that during the spring-summer season when this study was carried out, the bharal number did not exceed 100, a complete order of magnitude less than the livestock number in the area.

Oli *et al.*(1994) assessed the impact of perceived snow leopard predation on livestock in Manang district of Nepal, and found that the loss per household represented a quarter of the average annual *per capita* Nepalese income. In the present study, the perceived loss to wild predators per household and per individual was almost two fold higher, amounting to 52 % and 11 %, respectively, of the annual *per capita* income of Himachal Pradesh (US$ 248) for 1994-95 (World Bank 1996). The loss was only marginally reduced after incorporating the amount received as financial compensation (50 % and 10.6 % of the average annual *per capita* income respectively).

For reasons discussed earlier, the levels of livestock depredation and the consequent economic damage presented in this paper surely exceed the actual loss due to wild predators. There is little doubt, however, that a serious conflict exists between the wild predators and the agro-pastoralists. Even during the course of 4 months that I spent in field, 7 goat/sheep and a horse belonging to the study villages were reportedly killed by wild predators, and another horse injured. The identity of the predator was mostly unavailable with the exception of the horse which was killed by snow leopard. In any case, the tendency for people to attribute, often unintentionally, most cases of livestock death to the wild predators, accentuates the conflict. This is because when peoples' tolerance towards the wild predators is in question, it is the loss they perceive, rather than the actual loss, which can lead them to retaliate.

Reducing the conflict

Contemporary management strategies to minimize livestock depredation by wild carnivores involve elimination of specific animals causing damage, improved anti-predator and general livestock management, and compensation for livestock lost to predators (Nowell and Jackson 1996). In India, Schedule I species (Anon. 1992) such as the Tibetan wolf and the snow leopard cannot be destroyed by law for reasons such as livestock depredation (Sawarkar 1986). Oli *et al.* (1994) outline specific management strategies to reduce the snow leopard-pastoralist conflict, and emphasize the need for financial compensation schemes. Such a scheme does exist within the forest department in Kibber. However, in the year 1995, people applied for compensation for only about 41 % of the perceived livestock predation cases. Low compensation rates (6-20 % of market value), bureaucratic apathy, and the time and costs involved in securing compensations discouraged people from applying to such schemes. The amount locals claimed to have received as compensation in the year 1995 represents less than 3 % of the perceived annual economic loss due to wild predators. Moreover, locals claimed to have received financial compensation in only 52 % of the cases for which they had applied. It is clear that the existing compensation scheme can do little to reduce the human-wildlife conflict in this area. Such disinterest in existing Government financial schemes, for similar reasons, has been reported from elsewhere in India (Saberwal *et al.* 1994).

Preliminary discussions with the locals indicated a willingness from most families to contribute an equivalent of US$ 1 (4.8 % of the average monthly *per capita* income) per month if a self-financed compensation scheme is developed in the area. It is recommended that the local wildlife department along with non-governmental organizations set up a committee of the village community to manage the funds and decide the compensation rates. This fund would need to be strengthened with corpus grants from national and international conservation agencies. There is also a need to evolve methods for ascertaining the cause of livestock death.

In summer, the livestock are penned adjacent to houses at night. These pens are small enclosures (up to 10 m X 20 m) with ca. 1.5 m high walls and no ceiling. Snow leopard occasionally raid these pens. The kills inside villages, for obvious psychological reasons, cause greater resentment among the locals. In some houses in Gete, one of the study villages, people have covered their pens with chain link fences, which according to them has substantially cut down instances of kills inside the village. Providing chain-link fences to the locals would be a small but important step in reducing the conflict. For this, I estimated a one time investment of about US$ 75 per family. This cost could be met either by the state, conservation agencies, the village community fund mentioned above, or a combination of these.

It is important to note that such schemes can provide only a short-term pacification. The conflict in the long run is likely to intensify unless the problem of growing stock sizes is addressed. Persecution by humans in response to livestock predation in historical times has eliminated several carnivores including the tiger *Panthera tigris*, lion *Panthera leo*, and puma *Felis concolor*, from large parts of their former range (Novell and Jackson 1996). In Kibber the wolf has faced the brunt of the agro-pastoralists' retaliation. This is despite their belief that most livestock kills presently made are by the snow leopard. The persecution of wolf is possibly related to the relative ease in locating dens and capturing litters. So far there has been no attempt to actively eliminate the snow leopard. Such cases, however, have been reported for trans-Himalayan Buddhist communities elsewhere (Fox and Chundawat 1988). With losses equivalent to half of the average annual *per capita* income for every household, it is highly probable that unless urgent extenuatory measures are undertaken in Kibber wildlife sanctuary, active elimination of snow leopard would be resorted to in the near future.

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Appendix One

Avifaunal Survey of Tsomoriri Lake and Adjoining Nuro Sumdo Wetland in Ladakh, Indian Trans-Himalaya

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Abstract: We report the results of a ten day avifaunal survey (19-28 July, 1996) of Tsomoriri Lake and the adjoining Nuro Sumdo wetland in eastern Ladakh, Indian trans-Himalaya. Thirty-four bird species were identified, including 14 water birds which breed in the area. We sighted at least 3 individuals of the endangered blacknecked crane *Grus nigricollis*, and 826 barheaded geese *Anser indicus*. A breeding colony of brownheaded gull *Larus brunnicephalus* comprising of approximately 250 adults and chicks was sighted. The wetlands are threatened by pollution due to increased tourism. The necessity of developing Nuro Sumdo into a protected area, and the formulation of an ecologically sensitive tourism plan is emphasized.

INTRODUCTION

The high mountain lakes and bogs in Ladakh region of the Indian trans-Himalaya represent the only breeding grounds of barheaded geese *Anser indicus* in India, and the only breeding grounds of the blacknecked crane *Grus nigricollis* outside China. The largest of these lakes entirely within Indian limits is the Tsomoriri, believed to be the most important breeding locality for water fowl in Ladakh (Directory of Indian wetlands, 1993). In this paper, we report the results of an avifaunal survey of the Tsomoriri lake and an adjoining wetland called Nuro Sumdo. We discuss the conservation problems in the area. The survey was conducted between 19-28 July, 1996.

STUDY AREA

Tsomoriri lake (32° 07' N to 32° 50' N and 78° 03' E to 78° 20' E) in eastern Ladakh is spread over an area of ca. 120 km^2 of the Rupshu Desert in the northernmost Indian state of Jammu & Kashmir. This high altitude fresh water lake is situated at about 4650 m above mean sea level, and remains frozen in winter. The land-locked lake is fed by springs and snow melt and has a maximum depth of 40 m. On the north and east, the lake is bounded by rolling hills of the Tibetan cold desert. The western side is bordered by steeper peaks exceeding 5500 m. Pare Chu river, which originates about 40 km upstream, flows on the southern side. Between Tsomoriri in the north, and Pare Chu in the south, lies the Nuro Sumdo wetland, covering an area of ca. 20 km^2. Unlike Tsomoriri, Nuro Sumdo is a bog, criss-crossed by small rivulets which eventually drain into the Pare Chu.

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The area is characterized by an arid, cold desert climate. Summer temperature ranges from 0° to 30° C, which falls to –10° to –40° C in winter (Directory of Indian wetlands, 1993). *Caragana* and *Astragalus* species characterize the steppe vegetation, while *Potamogeton* species occur in shallow parts of Tsomoriri lake (Directory of Indian wetlands, 1993). The bogs in Nuro Sumdo include several species of *Carex*, *Primula*, and *Pedicularis*. Other common species are *Juncus thomsonii* and *Leontopodium* sp. Large mammalian fauna in the area includes ungulates such as nayan (*Ovis ammon hodgsoni*), bharal (*Pseudois nayaur*), and kiang (*Equus kiang*). Large carnivores reported to occur are the snow leopard (*Uncia uncia*) and the Tibetan wolf (*Canis lupus chanku*).

METHODS

We traversed a total distance of 140 km on foot in the surveyed area, which included the *c.* 90 km perimeter of Tsomoriri. Birds were observed using 7 X 50 and 7 X 42 binoculars. While all species of birds were recorded, we enumerated only the water birds. For water fowl, the birds were classified as adult or young based on their relative size. We tried to avoid double counts by:

(i) rejecting sightings with even a small possibility of double counting
(ii) dividing into two teams of 2 observers each, who radiated out in opposite directions along the Tsomoriri. We could thus simultaneously census the opposite banks (*c.* 3-6 km apart), reducing the chances of double counting.

RESULTS

Thirty-four species of birds were identified in the surveyed area which included 14 species of water birds (Appendix Ia). A bunting *Emberiza* sp. and a finch could not be identified. Three adult blacknecked cranes were seen in the north eastern part of Nuro Sumdo. We saw a single adult in the same area five days later, which was probably a double count. A total of 805 barheaded geese were counted in Tsomoriri, and another 21 in Nuro Sumdo. This population comprised of 62 % goslings (average size partridge+). We found a nesting colony of brownheaded gulls *Larus brunnicephalus* on an island 50 m off the northern bank of Tsomoriri. This *c.* 30 m X 6 m island consisted of an estimated 250 adults and chicks. Along the northern bank, we also found 6 nests of great crested grebe *Podiceps cristatus* with eggs. Census results for all the 14 water birds are summarized in Table 1.

DISCUSSION

The trans-Himalaya is one of the most fragile, and yet the least represented of all the biogeographic zones in the Indian protected area network (Rodgers & Panwar 1988). This biogeographic zone harbours 12 mammal and bird species listed in Schedule I of the Indian Wildlife (Protection) Act, 1972 (Anon. 1992). Among the birds, the blacknecked crane and the Tibetan snowcock *Tetraogallus tibetanus* occur in the surveyed areas.

A pair of blacknecked cranes has earlier been reported to breed in the area (Directory of Indian wetlands, 1993). The rare blacknecked grebe *Podiceps nigricollis* has also been reported to breed in the area, though it was not sighted during this survey (Directory of

Indian wetlands, 1993). The survey confirmed the use of these wetlands for breeding by 13 other species of water birds. While the Nuro Sumdo area seems important for black necked crane, Tsomoriri is an extremely important breeding area for barheaded geese.

Table 1. Water bird census of Tsomoriri and Nuro Sumdo wetlands in eastern Ladakh, Indian trans-Himalaya

			Tsomoriri	***Nuro Sumdo***
Ruddy shelduck	*Tadorna ferruginea*	Adult	26	12
		Young	56	14
Barheaded goose	*Anser indicus*	Adult	306	8
		Young	499	13
Mallard	*Anas platyrhyncos*		1	0
Common pochard	*Aythya ferina*		2	0
Common merganser	*Mergus merganser*	Adult	5	0
		Young	6	0
Blacknecked crane	*Grus nigricollis*		0	3
Common redshank	*Tringa totanus*		11	1
Green sandpiper	*T. ochropus*		7	1
Common sandpiper	*T. hypoleucos*		7	1
Mongolian plover	*Charadrius mongolus*		33	0
Brownheaded gull	*Larus brunnicephalus*		283*	0
Common tern	*Sterna hirundo*		7	3
Great crested grebe	*Podiceps cristatus*	Adult	16**	0
		Young	7	0
Whitethroated dipper	*Cinclus cinclus*		3	2
Unidentified ducks			31	0
Unidentified waders			3	0

* including a nesting colony of an estimated 250 birds.
** including 6 adults attending a nest each with eggs.

The survey corroborates the importance of Tsomoriri and Nuro Sumdo from an avifaunal viewpoint. While their conservation significance is evident, developmental activities and increasing tourism threaten these important wetlands. The area had remained closed to tourism because of its location close to the politically sensitive Sino-Indian border. However, with its opening up in 1992, Korzok, the only village in the vicinity of the wetlands, has become an important tourist centre. A road from Leh - an important tourism centre 200 km northwest - to Korzok runs for more than 5 km along the Tsomoriri. Apart from representing one of the highest inhabited places in the world, Korzok has an important Buddhist monastery. The village lies along the north western edge ofTsomoriri, and consists of *c.* 75 households, largely belonging to a semi-nomadic pastoral tribe called *Changpa*. *Changpa* livestock, which includes goat, sheep, cattle, horses, donkeys, and yak (*Bos grunniens*), graze in the bogs and meadows of the wetlands. In addition, several government establishments exist in Korzok. There are plans to construct a hotel. During the survey, several tourist groups were camping by the Tsomoriri. Tourist vehicles are driven right up to the lake. We found discarded garbage including metal cans and polythene not only around Korzok, but also in the more remote areas of Nuro Sumdo. This is because an old 125 km long trade route linking Korzok in the north to the villages around Kibber Wildlife Sanctuary in the south (in the adjoining state of Himachal Pradesh), has now become a popular trekking route. This route passes through the entire western side of Nuro Sumdo and Tsomoriri. Several tourist groups with donkeys and mules do this trek every year. Although tourism is restricted to the short summer, this is the breeding time for the avifauna.

We suspect that like elsewhere in the Himalaya, the ecosystem homeostasis that traditionally characterized the trans-Himalayan Buddhist communities, is degenerating in the area (Goldstein 1981). Polyandry, a traditional social system which restricted the growth of the *Changpa* population, is breaking down (Bhattacharji, 1993). With increasing tourism, Korzok seems headed towards a market economy. Apart from tourists and tour organizers, a floating summer population from other parts of the state is developing. Shops catering to the increased demands of tourism are being run seasonally by this migrant population. Given the present situation, along with an obvious lack of any drainage system in this remote, hilly village, pollution of Tsomoriri in the near future is not difficult to foresee. Similarly, with the growing popularity of the Korzok-Kibber route, currently advertised by several trekking agencies, pressure on the Nuro Sumdo wetland and the *c.* 15 camp-sites along the route is likely to increase rapidly.

Administratively, Tsomoriri has been declared as a wetland reserve, but Nuro Sumdo does not have a protected area status (Sahi 1993). So far, no measures have been undertaken towards the conservation of these wetlands. Affording a protected area status to Nuro Sumdo, and enforcing an ecologically sensitive tourism plan are urgently needed if these wetlands and their avifauna are to be conserved. The proposed change in status would lead to the formation of a large, contiguous trans-Himalayan conservation unit due to the presence of the 1400 km^2 Kibber Wildlife Sanctuary immediately south of Nuro Sumdo.

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Appendix Ia. Birds sighted in Tsomoriri and Nuro Sumdo wetlands, eastern Ladakh, Indian trans-Himalaya

Common Name	*Latin Name*
1. Tibetan snowcock	*Tetraogallus tibetanus*
2. Ruddy shelduck	*Tadorna ferruginea*
3. Barheaded goose	*Anser indicus*
4. Common merganser	*Mergus merganser*
5. Hill pigeon	*Columba rupestris*
6. Blacknecked crane	*Grus nigricollis*
7. Tibetan sandgrouse	*Syrrhaptes tibetanus*
8. Common redshank	*Tringa totanus*
9. Green sandpiper	*T. ochropus*
10. Common sandpiper	*T. hypoleucos*
11. Mongolian plover	*Charadrius mongolus*
12. Brownheaded gull	*Larus brunnicephalus*
13. Common tern	*Sterna hirundo*
14. Golden eagle	*Aquila chrysaetos*
15. Common kestrel	*Falco tinnunculus*
16. Great crested grebe	*Podiceps cristatus*
17. Redbilled chough	*Pyrrhocorax pyrrhocorax*
18. Common raven	*Corvus corax*
19. Whitethroated dipper	Cinclus cinclus
20. Black redstart	*Phoenicurus ochruros*
21. Guldenstadt's redstart	*P. erythrogaster*
22. Desert wheatear	Oenanthe deserti
23. Sand martin	*Riparia riparia*
24. Eurasian crag martin	*Hirundo rupestris*
25. Greater short-toed lark	*Calandrella brachydactyla*
26. Eurasian skylark	*Alauda arvensis*
27. Horned lark	*Eremophila alpestris*
28. Blackwinged finch	*Montifringilla adamsi*
29. White wagtail	*Motacilla alba*
30. Yellowhooded wagtail	*M. citreola*
31. Robin-accentor	*Prunella rubeculoides*
32. Great rosefinch	*Carpodacus rubicilla*